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ORIGINAL ARTICLE

Effects of extracorporal shock wave therapy on symptomatic heel spurs: a correlation between clinical outcome and radiologic changes

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Abstract Plantar heel pain, a chronic and disabling foot alignment, occurs in the adult population. Extracorporal shock wave therapy (ESWT) offers a nonsurgical option in addition to stretching exercises, heel cups, NSAI, and corticosteroid injections. This study aimed to investigate the effects of ESWT on calcaneal bone spurs and the correlation between clinical outcomes and radiologic changes. The study involved 108 patients with heel pain and radiologically diagnosed heel spurs. All patients underwent ESWT once a week for 5 weeks at the clinic. Each patient received 2,000 impulses of shock waves, starting with 0.05 mJ/mm2 (1.8 bar) and increasing to 0.4 mJ/mm2 (4.0 bar). Standard radiographies of the affected heels were obtained before and after the therapy. Clinical results demonstrated excellent (no pain) in 66.7% of the cases, good (50% of pain reduced) in 15.7% of the cases, and unsatisfactory (no reduction in pain) in 17.6%. After five ESWT treatments, no patients who received shock wave applications had significant spur reductions, but 19 patients (17.6%) had a decrease in the angle of the spur, 23 patients (21.3%) had a decrease in the dimensions of the spur, and one patient had a broken spur. Therefore, results showed no correlation between clinical outcome and radiologic changes. The present study supports the finding that even with no radiologic change after ESWT therapy, the therapy produces significant effects in reducing patients' complaints about heel spurs.

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Introduction

Plantar heel pain, one of the most common regional pain syndromes, often causes severe discomfort and limits patients' daily lives. Discomfort when walking lowers a patient's quality of life, and the first step in the morning has diagnostic value. Distinguishing the differential diagnoses of heel pain is difficult. Detailed anamnesis and examination are important in determining heel pain as Achilles' tendinopathy or plantar fasciitis or the more rarely seen spondyloarthropathy or gout [1, 2].

Plantar fasciitis, known as a chronic inflammation of plantar fascia3 [3], appears in etiopathological studies as a noninflammatory tendinopathy—a mechanically induced enthesopathy at the calcaneal insertion of plantar fascia [4–6].

Clinical symptoms and anamnesis determine the diagnosis, with pain at the first step in the morning and pain after exercise, the most commonly reported symptoms. Palpations over the medial tubercule of the calcaneus can determine tenderness and pain. Clinicians must know of the associated symptoms that can indicate a systemic disease [2, 3].

In chronic heel pain, diagnostic imaging methods can detect the existence of specific anatomical structures. For soft tissue pathologies, such as plantar fasiit, ultrasonography and magnetic resonance imaging (MRI) are used, for osseous pathologies like calcaneal spur, plain film X-rays are used [7]. Despite the common use of these imaging methods, they offer limited benefits. The clinical and radiologic correlation is still under discussion.

Some cases require imaging studies such as lateral radiography and MRI to exclude stress fractures, tumors, and calcium deposits [2]. Practitioners must keep in mind that asymptomatic patients may suffer from bone spurs as well.

These abovementioned diagnostic imaging methods help to find the main cause of the disorder and to determine accurate treatments. In some cases, these methods provide objective criteria for evaluating the efficacy of treatment as well [7].

Risk factors for plantar fasciitis include obesity, gender (female), age (often over 30), and occupations that require prolonged standing. Structural and biomechanical factors (pes cavus, pronated foot, and limited plantar flexion range) can also cause plantar heel pain [2, 3].

The conservative treatment of plantar fasciitis with heel spurs consists of insole supports, nonsteroidal anti-inflammatory drugs, local steroid injections, and physical therapy [1, 8]. Nonsurgical management of plantar fasciitis proves successful in approximately 90% of patients. If conservative treatments fail after 6 months to a year, surgery, such as removal or release of the fascia and removal of bone spurs [3], may follow.

Recently, ESWT has been used for painful heel syndromes and other musculoskeletal problems, such as calcified tendinitis of shoulder, lateral epicondylitis, Achilles' tendinopathies, plantar fasciitis, and union and nonunion fractures [9–12]. The original treatment field of ESWT was lithotripsy, but in the past few years, ESWT has seen increasing use in the treatment of musculoskeletal injuries [11].

This study investigated the effects of extracorporal shock waves on calcaneal bone spurs and clarifying morphologic features of the calcaneal bone spur associated with clinical outcomes of ESWT.

Materials and methods

Between July 2009 and November 2009, 108 patients with symptomatic heel spurs underwent ESWT in our hospital. Inclusion criteria consisted of a painful heel for a minimum of 3 months with a heel spur radiologically examined and unsuccessful conservative treatment for 6 months before referral to our hospital. No other treatment or drugs (NSAI, steroids, other analgesics) were used for 4 weeks before the trials began or during the study period. We recorded patients' ages, gender, walking and exercise activities, occupations, duration of symptoms, previous treatments, radiographic findings, and follow-ups.

All patients had used analgesics and NSAI drugs, 9 (8.3%) used insole supports, and 21 (19.4%) received injections of local anesthesis and corticosteroids to the heel. We included patients who had received prior local corticosteroid injections in the study but required at least 3 months from the last injection to the first ESWT treatment. We excluded patients under 18 years and those with local infections, nerve entrapment syndrome, pregnancy, local tumors, coagulation disorders, and neurological disorders. None of these patients received bilateral treatment at the same time. All patients provided informed consent before treatment.

This study used a radial ESWT unit (EMS Medical, The Swiss Dolorcast, Switzerland); it provides pneumatically generated extracorporal shock wave impulses with different working pressures. Subjects reclined in a prone position, and a therapist stabilized their ankles. Shock waves were applied directly to the marked tender spot, and we used ultrasound gel as a coupling agent. Patients received five treatments (once a week), with the first treatment comprising 2,000 shocks at a frequency of 900 shocks per minute. The energy density used on the first treatment was 0.05 mJ/mm^2 (1.8) bar, and we gradually increased this to 0.4 mJ/mm^2 (4.0 bar) to avoid initial treatment pain.

We evaluated pain levels (before and after treatment) using the visual analogue scale (VAS), ranging from 0 = no pain to 10 = maximum pain. Patients also responded to a questionnaire, with all pain relieved described as excellent, 50% reduction as good, or the same as unsatisfactory.

Lateral X-ray examinations evaluated variations in the dimensions of calcaneal spurs. Before and after the therapy, we took a standard radiography of the affected heels, and a radiologist evaluated these films. This blind observer knew nothing of the patients' clinical status or outcomes. The radiographic variations observed included classification as reductions in the dimensions and the angle of calcaneal spurs.

Statistical analysis

Statistical analyses were done using SPSS 11.0 (Chicago, IL, USA) program for Windows. To compare the averages among the dependent groups, we used the dependent student T test as a parametric test and the Wilcoxon as the nonparametric test. To compare the averages of two independent groups, we used the student T test as the parametric test and Mann–Whitney U test as the nonparametric test. In addition, to compare the proportions of the independent groups, a Chi-square test was used, and the Spearman correlation test, a nonparametric test, was used to display the linear correlation between the two variables. We determined statistical significance as $P < 0.05$.

Results

Study subjects included 103 women (95.4%) and 5 men (4.6%) with an average age of 50.2 ± 11.3 years (range

20–78 years). The patients included 96 homemakers, four nurses, one student, two retirees, one salesperson, and three state officials. Of the total feet studied, we looked at 63 (58.3%) left feet and 45 (41.7%) right feet. The duration of symptoms averaged 27.4 ± 32.8 months (range 3–120 months). The average time since the previous therapy was 7.3 ± 9.2 (range 1–60 months).

	N	%
Women	103	95.4
Men	5	4.6

The clinical results showed excellent, with no pain in 66.7% of the cases, good (50% of the pain removed) in 15.7% of the cases, and unsatisfactory (pain remained the same) in 17.6% of the cases. After ESWT, the clinical evaluation of the 108 heels revealed a statistically significant decrease in the mean visual analogue scale of 5.19.

	Excellent	Good	Unsatisfactory
Clinical results (%)	66.7	15.7	17.6

After a radiogram check by a blind observer, we found no significant disappearance, but 19 (17.6%) of the patients had a decrease in the angle of the spur, 23 (21.3%) had a decrease in the dimensions of the spur, and one had breakage of the spur. We found no significant correlation between clinical outcomes and radiological changes. In addition, no correlation between clinical outcomes and the other three parameters (age, duration of symptoms, and previous corticosteroid injections) surfaced. No device-related problems occurred, and we observed no complications, except local reactions (redness, swelling, hematomas) and transient increases in pain levels.

	Decrease in the angle of spur	Decrease in the dimensions of spur	Breakage of the spur	No differences
Radiologic changes	19 (17.6%)	23 (21.3%)	1 (0.93%)	65 (60.19%)

Discussion

In this study, 108 patients with chronic heel pain and heel spurs underwent ESWT treatment to determine the resulting clinical and radiological changes. Although we observed improvements in the pain levels of the heel spurs, we found no correlation with the radiological changes.

The etiology of plantar heel pain, a common soft tissue disorder, remains unclear. A systematic review found two factors associated with chronic heel pain. These factors include body mass index and presence of calcaneal spur. This review also found evidence that increased age, decreased ankle dorsiflexion, decreased first metatarsophalangeal joint extension, and prolonged standing associated with chronic heel pain. Such a list of etiologic factors will help researchers in the search for correct treatment and suitable preventive strategies [13].

The role of calcaneal spurs in the pathogenesis of chronic heel pain remains elusive [14]. This lack of clarification may be due to the high prevalence of subcalcaneal spurs in the asymptomatic population [15]. However, a comparison of asymptomatic and symptomatic heel spur groups shows a strong association between chronic heel pain and the presence of subcalcaneal spurs [7]. Researchers have also found that variations in spur length (longer spurs may be more symptomatic) and concurrent fat pad abnormalities may significantly influence the occurrence of pain [16–18]. One study showed a strong association of subcalcaneal spur formation and pain beneath the heel [7].

Previously, researchers believed that repetitive longitudinal traction of the plantar fascia, subsequent inflammation, and reactive ossification play a major role in the formation of the heel spur [16, 19]. Recently, Li et al. [20] used a histologic and gross morphological study to show that heel spurs are generally not found in the direction of plantar aponeurosis or plantar muscles. They found that they are actually in the direction of stress on the calcaneus during standing and walking. This means a closer association with soft tissue, especially loose connective tissue, fibrocartilage, muscle, and aponeurosis. Finally, they consider these spurs' protective mechanisms of bone against repetitive stressful force and risk of microfractures. Tountas et al. [21] showed that calcaneal spurs can occur after surgical release of the plantar fascia.

First used in urology for the treatment of nephrolithiasis, over the past 10 years, ESWT has found success against orthopedic diseases such as pseudoarthrosis, tendinitis, epicondylitis, plantar fasciitis, and calcific tendinitis of the shoulder [9, 22].

Valchanou et al. [23] studied ESWT in the treatment of pseudoarthrosis and delayed union of fractures, stating that the shock waves break up sclerotic bones by producing microfissures and numerous bony fragments because of the difference in impedance between bones (and calculi) and soft tissues.

The analgesic and other biologic mechanisms of ESWT remain controversial. However, reports indicate that at the beginning of treatment, internal microdisruption of fascial tissue occurs and this facilitates the process of neovascularization and new tissue growth [22, 24–26].

ESWT raises a question as to whether it affects heel spurs by breaking the osseous parts or if it is only the anti-inflammatory and edematous effects that reduce heel pain. Our findings demonstrate the success of ESWT in reducing heel pain, even with no significant radiologic effects. We found no correlation between pain relief and radiologic changes; likewise, we found no correlation between clinical outcomes, ages, the duration of symptoms, and previous corticosteroid injections. Our study showed that the success of the therapy does not depend on parameters such as age of the patient, duration of the symptoms, or previous steroid injections. Furthermore, the overall positive outcome of the therapy is 80%, a positive outcome for all age groups.

Despite our findings, many controversial studies have investigated the effectiveness of ESWT on the management of plantar heel pain. Thomson et al. made a meta-analysis from six randomized controlled trials consisting of 897 patients with plantar heel pain. Their analysis criticized ESWT treatments and considered these treatments not significantly statistically effective for plantar heel pain [11].

Cosentino et al. [9] found that ESWT improves plantar heel pain symptoms and can structurally modify the heel spur ultrasonographically and radiographically. Buch et al. [27] showed that ESWT was effective for approximately 61.6% of the patient group.

From these results, it is clear that ESWT has a significant effect on symptomatic heel spurs. In all of these studies, there is not an important irreversible side effect. So, even the patients in the unsuccessful group, in our opinion, should have the opportunity to try this therapy as a last step in the conservative treatment.

Chuckpaiwong investigated 225 patients for ESWT outcome predictors. As in our study, they showed that radiologic plantar heel spurs, age, and duration of symptoms did not have a statistically significant effect on the outcome of ESWT. They also found no correlation between clinical results and gender, marital status, BMI, amount of exercise, bilateral symptoms, bilateral treatment, smoking, plantar fascia thickness (ultrasonographically), and associated foot pathology [28].

Melegati et al. [29] showed that previous local corticosteroid injections may negatively affect the result of ESWT. They examined 64 patients with painful subcalcaneal spurs and could not find any radiographic modifications.

Cosentino et al. [9] found in their study that at the end of the treatment, the inflammatory edema assessed by ultrasonography did not change, but 1 month later, the inflammatory edema had significantly decreased. Furthermore, in 30% of cases, they found a reduction in heel spurs of more over than 1 mm as we found in our study. This radiologic result is not statistically significant, but it is similar to our study.

A limitation of our study is the absence of a control group for assessing the treatment's success. Further studies should include a control group. Patients who had radiologically diagnosed calcaneal spurs but no pain are excluded from this study in order to find out the effectiveness of the ESWT system against pain in general. To determine the effect of the ESWT to the radiologic status, this group of patients could be a part of the following studies.

The results of ESWT in healing wounds support its effect on neovascularization and expansion of small microvessels [30]. Therefore, because our study showed statistically insignificant radiographic modifications, as did the results of other studies, we can relate the mechanism by which ESWT reduces heel pain to microvessel mechanisms. ESWT can improve blood circulation in the heel, support the removal of pain and inflammation-producing metabolism and result in pain reduction and improvement in daily life.

Nemegyeina et al. reviewed heel pain and made a step-by-step therapy scheme for heel pain. In their scheme, the first step involves risk-factor modification and NSAID and orthotics, such as heel pads, Achilles' tendon stretching, and, if necessary, an ankle dorsiflexion night splint. If these steps fail, the next treatment is local injections of steroids. If the injections are ineffective, ESWT must be considered. If there is still no success in treatment, surgery represents the last option [22].

Among the patients in our study, 20% had no improvement in clinical symptoms, but the reasons for this outcome could not be found. Compared to other studies, this ratio seems nearly constant at the level of 1/5–2/5. The reasons for these outcomes must be investigated by further studies.

Probably in PMR clinics, ESWT is not considered as a suitable therapy for the first line management of heel pain. This may be because of limited access to new and expensive equipment, or it may be because of the self-limited cycle of heel pain history.

Our results confirm that the dimensions of heel spurs do not correlate with ESWT outcome, and possibly with the availability of these devices to all institutes, it will become the first treatment for heel pain because of its lack of side effects and repeatable usage.

Conclusion

The present study found that practitioners should consider ESWT as an effective treatment for painful calcaneal spurs.

However, we found it only effective at the point of pain and not in radiographic results.

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